

NASA-CR-205045

FINAL REPORT

on

SPECIALIZED TECHNICAL ASSISTANCE IN STUDIES OF MICROGRAVITY

NASA Grant KSK-R10

by

Edward G. Keshock, Principal Investigator

July, 1997

Technical assistance was provided in connection with three projects, namely (1) Capillary Heat Transfer (CHT) Glovebox Experiment, (2) Technological Evaluation of the Microgravity Isolation Mount (MIM) Glovebox Experiment, and (3) Two-Phase Annular Flow in Helical Coil Flow Channels in a Reduced Gravity Environment.

Capillary Heat Transfer Glovebox Experiment

The immediate goal in this study was to construct an apparatus for simulating the formation of vapor bubbles that could potentially disrupt the CHT experiment. The result of this effort was that a bubble removal simulation device was developed which formed the basis for the design and fabrication of a portable unit. This unit was employed during crew training in Huntsville, Alabama in preparing the crew members to deal with the appearance of vapor bubbles in the CHT experiment.

Technological Evaluation of the MIM Experiment

The immediate goal of this effort was to facilitate the analysis of videographically recorded data during the TEM experiment.

As a result of this effort, the video tapes containing TEM data were prepared for analysis by having timing data encoded directly on the tapes. This allowed the evolution of disturbances of the liquid free surface to be analyzed with respect to time. A method employing a microcomputer based video analysis system was then tested and found to be satisfactory for temporal and spatial measurements of liquid free surface disturbances. The tapes are currently being analyzed by a student assistant at Baldwin Wallace College.

Final
MIM
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Two-Phase Annular Flow in Helical Coil Flow Channels
in a Reduced Gravity Environment

The immediate goal of this effort was to obtain pressure drop data and flow visualization information for two-phase air-water flow in helical coils, tested under earth gravity conditions.

The results achieved necessitated first preparing a 3/4" I.D. diameter helical coil for conducting two-phase flow ground tests, by connecting and installing that test section in an existing two-phase testing facility at NASA Lewis. Also, it was necessary to install instrumentation and connect that instrumentation to a data acquisition system for the purpose of obtaining measurements of pressure drop across the coiled test section. Initial measurements of pressure drop were made for vertical upward and downward flow, in addition to identifying flow patterns over a range of flow conditions. The flow pattern observations were compared with existing flow pattern maps in the literature.

NEW TECHNOLOGY DISCLOSURE		NT CONTROL NO. <i>(Official use only)</i>	
NASA Task Manager Contractor Bhim Singh		Task Manager or Grantee Principal Investigator Edward G. Keshock	
<p>This form is used by NASA contractors, subcontractors, grantees, and grantee subcontractors when reporting patentable and non-patentable inventions, discoveries, improvements or innovations (including computer software) to NASA. Use of this report form is optional, however, an alternative format must at a minimum contain the information required herein.</p> <p>When necessary, attach additional documentation to provide a full, detailed description.</p>			
1. TITLE Specialized Technical Assistance in Studies of Microgravity Two-Phase Flow and Capillary Pumped Loops			
2. INNOVATOR(S) <i>(Name, Social Security No., and Home Address)*</i> Edward G. Keshock			
3. EMPLOYER (Organization and division) Cleveland State University Mechanical Engineering			
4. ADDRESS (Place of Performance) 1983 East 24 th Street Cleveland, Ohio 44115			
5. NASA PRIME CONTRACT/GRANT NO. NCC 3-507		6. CONTRACTOR DISCLOSURE NO. and TASK NO.	
SECTION I - DESCRIPTION OF THE PROBLEM THAT MOVTIVATED THE TECHYNOLOGY DEVELOPMENT (Enter A.-General Description of Problem Objective; B.-Key or Unique Problem Characteristics; C.-Past History/Prior Techniques; D.-Limitations of Prior Techniques) n/a			

SECTION II-TECHNICALLY COMPLETE AND EASILY UNDERSTANDABLE DESCRIPTION OF NEW TECHNOLOGY THAT WAS DEVELOPMED TO SOLVE THE PROBLEM OR MEET THE OBJECTIVE (Enter as appropriate A.-Specific description of item; B.-State of development; C.-Operation as a unit; D.-Functional operation; E.-Supportive theory; F.-Engineering specification; G.-Peripheral equipment; H.-Drawings, graphs, etc.; I.-Parts or ingredients lists; and J.-Maintenance, reliability, safety factors)

n/a

SECTION III-UNIQUE OR NOVEL FEATURES OF THE TECHNOLOGY AND THE RESULTS (OR BENEFITS) OF ITS APPLICATION
(Enter as appropriate A.-Novel or unique features; B.-Development or conceptual problems; C.-Operating characteristics, test data; D.-Analysis of capabilities; E.-Source of error; and F.-Advantages/shortcomings)

n/a

SECTION IV-SPECULATION REGARDING USEFUL NON-AEROSPACE APPLICATIONS OF THE INNOVATION OR TECHNOLOGY
/na

SECTION IV (Continued)

n/a

SECTION V-ADDITIONAL DOCUMENTATION (Include or list below any pertinent documentation which aids in the understanding or application of the new technology. IF NOT TOO BULKY OR DIFFICULT TO REPRODUCE, INCLUDE COPIES WITH THIS REPORT. For those references or additional documentation available but NOT included in this report *due to their being nonessential to a basic understanding of the new technology and which may be costly to reproduce or handle) complete item 1, below)

A. AVAILABLE DOCUMENTS (Check and complete)	<input type="checkbox"/> 1. PAPERS, ARTICLES	<input type="checkbox"/> 4. ASSEMBLY/MFG.DRAWINGS	<input type="checkbox"/> 7. TEST DATA
	<input type="checkbox"/> 2. CONTRACTOR REPORTS	<input type="checkbox"/> 5. PARTS OR INGRED LIST	<input type="checkbox"/> 8. SEMBLY/MFG.PROCED
	<input type="checkbox"/> 3. ENGINEERING SPECS.	<input type="checkbox"/> 6. OPERATING MANUALS	<input type="checkbox"/> 9. COMPUTER TAPES/CARDS
	<input type="checkbox"/> 10. OTHER (SPECIFY)		

B. INCIDATE THE DATES OR THE APPROXIMATE TIME PERIOD DURING WHICH THIS TECHNOLOGY WAS DEVELOPED (I.E. CONCEIVED, CONSTRUCTED, TESTED, ETC.)

C. LIST THE FIRST PUBLICATION OR PUBLIC DISCLOSURE OF THE NEW TECHNOLOGY, AND DATES

D. LIST THE DATES AND ANY PARTICULARLY PERTINENT PAGE NUMBERS OF OTHER PUBLICATION SWHICH ARE AVAILABLE BUT NOT ATTACHED

E. DEGREE OF TECHNOLOGICAL SIGNIFICANCE (Check in your best judgment the statement which best expresses the degree of technological significance of this technology)

☐ 1. MODIFICATION TO EXISTING TECHNOLOGY ☐ UBSTANTIAL ADVANCE IN THE ART ☐ MAJOR BREAKTHROUGH

KEYWORDS (list 5-10 words)

SIGNATURES(S) OF INNOVATOR(S)

DATE

CLEVELAND STATE UNIVERSITY

GRANT EQUIPMENT INVENTORY

UPDATE: ☐

INTERIM: ☐

FINAL: ☒

GRANT NO.: NCC 3-507

SUPPL. NO. (If Applicable) _____

ORS No:

KSK-R10

GRANT BEGINNING DATE: 10/9/96

GRANT EXPIRES ON: 4/8/97

PRINCIPAL INVESTIGATOR: Edward G. Keshock

(SIGNATURE)

(DATE)

GRANT TITLE: Specialized Technical Assistance in Studies of Microgravity Two-Phase Flow and Capillary Pumped Loops

GRANTEE-ACQUIRED EQUIPMENT: EQUIPMENT WHOSE ACQUISITION COST IS \$1,000 OR GREATER THAT WAS PURCHASED OR FABRICATED WITH GRANT FUNDS BY A GRANTEE.

<u>Description</u>	<u>Model#</u>	CSU <u>REQ. NO.</u>	ACQ. <u>DATE</u>	Equip <u>Cost</u>	*Cond. <u>Code</u>	TAG NO.	<u>Location</u>
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n/a

THE PRINCIPAL INVESTIGATOR WISHES TO RETAIN POSSESSION OF THIS EQUIPMENT UPON EXPIRATION OF THE GRANT: YES ☐ NO ☐

*Equipment Condition Codes: 4=Good 7=Repairs Req'd (<15% of Acq Cost) X=Salvage (>65% of Acq Cost)
5=Fair 8=Repairs Req'd (16-40% of Acq Cost) S=Scrap (Value is material Content only)
6=Poor 9=Repairs Req'd (41-65% of Acq Cost)

GOVERNMENT-FURNISHED EQUIPMENT INVENTORY

Grant No.: NCC 3-507

ORS No: KSK-R10

Principal Investigator: Edward Keshock

Grant Expiration: 4/8/97

Status: Final

DISPOSITION INSTRUCTIONS

- ☐ RETURN
- ☐ TRANSFER TO ANOTHER GRANT
- ☐ RETAIN

<u>Description</u>	<u>Model#</u>	<u>Furnished Date</u>	<u>Equip Cost</u>	<u>*Cond. Code</u>	<u>Location</u>
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n/a

(I, the principal investigator, certify that the above information is correct) (Date)

*Equipment Condition Codes: 4 = Good 7=Repairs Req'd (<15% of Acq Cost) X=Salvage (>65% of Acq Cost)
5 = Fair 8=Repairs Req'd (16-40% of Acq Cost) S=Scrap(Value is material Content only)
6=Poor 9=Repairs Req'd (41-65% of Acq Cost)

NASA GRANTEE NEW TECHNOLOGY REPORT

NASA requires each research grantee, research contractor and research subcontractor to report new technology to the NASA Technology Utilization Office. The required reports and corresponding schedules are as follows:

<u>Title of Report</u>	<u>Form Number</u>	<u>Timetable</u>
Individual Disclosure	NASA 666A	The grantee discloses each discovery of new technology individually, at the time of its discovery
Interim Report	LeRC-GNTR	For multi-year grants, the grantee summarizes the previous year's disclosures on an annual basis. The first Interim New Technology (NT) Report is due exactly 12 months from the effective date of the grant.
Final Report	LeRC-GNTR	The grantee submits a cumulative summary of all disclosed discoveries. This Final NT Report is submitted immediately following the grant's technical period of performance.

Grantee Name and Address: Edward G. Keshock
Cleveland State University
1983 East 24th Street
Cleveland, Ohio 44115

Report Submitted by: Edward G. Keshock
Telephone Number: (216) 687-3630

NASA Grant Title: Specialized Technical Assistance in Studies of Microgravity Two-Phase Flow & capillary Pumped

NASA Grant Number: NCC 3-507

NASA Project Manager: Bhim Singh

Grant Completion Date: 04/08/97

Today's Date: 07/22/97

New technology may be either reportable items or subject inventions.

A **reportable item** is any invention or discovery, whether or not patentable, that was conceived or first actually reduced to practice during the performance of the grant, contract or subcontract. Large business contractors and subcontractors must disclose reportable items as they are discovered and submit a noncumulative list of these new technology items on an annual basis[ref.: Interim NT Report] and a cumulative list at the completion of the grant, contract or subcontract period [ref.: Final NT Report].

A **subject invention** is any invention or discover, whether or not patentable, that was conceived or first actually reduced to practice during the performance of the grant, contract or subcontract. Grantee, small business contractors and subcontractors must, at a minimum, disclose subject inventions as they are discovered and submit a cumulative list of these new technology items on an annual basis[ref.: Interim NT Report] and list at the completion of the grant, or subcontract period [ref.: Final NT Report].

Grantees, small business contractors and small business subcontractor are only required to disclose and report patentable items (subject inventions). We request, however, that small business contractors and subcontractors disclose both patentable and nonpatentable (reportable) items, both of which are automatically evaluated for publication as NASA *Tech Brief* awards.

PLEASE COMPLETE THE REVERSE SIDE OF THIS FORM AND MAIL TO THE FOLLOWING ADDRESS:

NASA LEWIS RESEARCH CENTER
ATTN: KAREN GRASSE
TECHNOLOGY UTILIZATION OFFICE; MAIL STOP 7-3
CLEVELAND, OHIO 44134

I General Information

1. Type of Report ☐ Interim ☒ Final
2. Size of Business: ☐ Small ☐ Large ☒ Nonprofit Organization
3. Have any nonpatentable new technology items resulted from work performed under this grant during this reporting period?
☐ yes ☒ no
4. Have any patentable new technology items resulted from work performed under this grant during this reporting period?
☐ yes ☒ no
5. Are new technology items (nonpatentable or patentable) being disclosed with this report?
☐ yes ☒ no

II New Technology Items

Please provide the title(s) of all new and previously disclosed new technology items conceived or first actually reduced to practice under the is grant. If this is an interim report, previously disclosed items need not be mentioned.

Title	Internal Docket Number	Patent Appl. Filed	Patentable Item	Nonpatentable Item
1.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

III Subcontractors

Please complete the following section listing all research subcontractors participating to date. Include each subcontractor's name, address, contract person, and telephone number. If this is an interim report, previously noted subcontractors need not be mentioned.

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Use of the forms identified on the reverse side of this page is optional; however, an alternate must at a minimum contain the information required by these forms.